Space Feeding Problems: A Bibliography •

TECHNICAL LIPBARY

U. S. Mamy NATICK LABORATORIES MATICK, MASS.

Space feeding problems arise from three basic conditions which must be understood before any practical solutions may be found. They are: (1) the physical conditions of the space which the flights traverse, (2) the restrictions imposed by the size and shape of the vehicle in which the flight is made, and (3) the basic food, oxygen and water needs of man during the flights. All three conditions are so closely related when approached from the view of space feeding that in a bibliography it is not possible to isolate the individual problems and cite the necessary background references for each. This bibliography, as a result, follows a different, more eclectic system in order to include a great many references which contain the information needed to think logically on the problems involved and to conduct research on the actual space feeding problems that may have to be faced sooner than might be predicted. The list is selected rather than complete.

GENERAL MATERIALS ON MAN IN SPACE

- Armstrong, H. G., Haber, Heinz, and Strughold, H. The aero medical problems of space travel. J. Aviation Med., 20, 383-402 (1949). In Epitome of Space Medicine, paper
- DuBridge, Lee A. The Challenge of the Space Age. 1958. California Institute of Technology, Pasadena, Cal. Keynote address before the Western Space Age Conference and Exhibit, Los Angeles, March 1958. Points out the scientific value of satellites, but doubts the military value.

Fenn, Wallace O. The challenge of space biology. AIBS Bulletin, 8 (2), 15 (1958).

Haber, Heinz. Man in Space. 1953. Bobbs-Merrill, Indianap-

Mallan, Lloyd. Men, Rockets, and Space Rats. 1956. Julian Messner, New York.

Man's new world. III. Into the far frontier beyond earth. Life, 44 (1), 52-66 (1958).

Mayo, A. Some survival aspects of space travel. J. Aviation Med., 28, 498–503 (1957).

Neimark, Paul G. ed. The Race for Space. 1957. Camerarts Pub. Co., Chicago. Fifteen articles covering phases of the space problem, other than food.

Oberth, Hermann. Man in Space. 1957. Harper & Bros., New York. Oberth is considered by some as the "father of space travel.

Oberth, Hermann. Wege zur Raumschiffahrt. 1929. R. Oldenburg, Munich, Germany.

The principle of the thing. Indust. Bul. (Arthur D. Little), no. 347, 3-4 (1957).

Rosen, M. W. Down-to-earth view of space flight. Machine Design, 25, 284 (1953).

Smith, E. T. B. Technical review. J. Brit. Interplanet. Soc., 15. 338-42 (1956).

Truax, R. C. We can have space flight in our time. Fourth International Astronautical Congress. Space flight problems. 1953. Lauburche & Cie, Biel-Bienne, Switzerland. p. 212-13.

Present address: Mississippi State College, State College,

Mississippi.

James G. Hodgson and Robert G./Tischer

Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois

U. S. President's Science Advisory Committee. Introduction to Outer Space. 1958. U. S. Govt. Print. Off., Washington. James R. Killian, jr., Chairman.

U. S. Congress. Select Committee on Astronautics and Space Exploration. Astronautics and space exploration; Hearings, 85th Cong., 2nd Sess., April 15 through May 12, 1958. Washington, U. S. Govt. Print. Off., 1958. 1,542 p.

Space Travel

Biological problems of space flight; a report of Professor Haldane's lecture. J. Brit. Interplanet. Soc., 10, 154-55

Burgess, Eric. Rocket Propulsion; with an Introduction to the Idea of Interplanetary flight. 1952. Chapman & Hall, London.

Clarke, Arthur C. Exploration of Space. 1951. Harper & Bros., New York; Temple Press, London.

Clarke, Arthur C. Interplanetary Flight. 1950. Temple Press, London; Harper & Bros., New York.

Gatland, K. W., and Kuensch, A. M. Space Travel. 1953. Philosophical Library, New York.

Goodwin, Harold L. Science Book of Space Travel. 1954. Franklin Watts, New York.

Ley, Willie. Rockets, Missiles, and Space Travel. 1951. Viking Press. New York. Previous editions under slightly different titles.

Ley, Willie. Satellites, Rockets and Outer Space. 1958. New American Library, New York. (A Signet Key book, KS

Ley, Willie, and others. Complete Book of Satellites and Outer Space. 2nd ed. 1957. Maco, New York.

Nicolson, Marjorie H. Voyages to the Moon. 1947. Macmillan.

Vaeth, Joseph G. Two Hundred Miles Up; the Conquest of the Upper Air. 1951. Ronald Press, New York.

Getting Into Space

von Braun, W. The Mars Project. 1953. University of Illinois

Press, Urbana, Ill. Burgess, Eric. Guided Weapons. 1957. Chapman & Hall, London.

Cardin, Martin. Vanguard: The Story of the First Man-made Satellite. 1957. E. P. Dutton & Co., New York. Clarke, Arthur C. The Making of a Moon. 1957. Harper &

Bros., New York.

Coombs, Charles. Rockets, Missiles and Moons. 1957. William Morrow, New York.

Strughold, Hubertus. A simple classification of the present and future stages of manned flight. J. Aviation Med., 27, 328-31 (1956). In Epitome of Space Medicine, paper 31.

The Planets

Ambartsumyan, V. A. ed. Theoretical Astrophysics; trans. from the Russian by J. B. Sykes. 1958. Pergamon Press. New York.

Ehricke, Kraft A. Analysis of orbital systems. Ber. den 5, Intern. Astronaut. Kongress, Innsbruck. 1954. Springer-Verlag, Vienna.

Firsoff, V. A. Our Neighbour Worlds. 1953. Philosophical Library, New York.

Haber, Heinz. Flight at the borders of space. Sci. American,

185, 2023 (Feb. 1952). Hener, Kenneth. Men of Other Planets. 1951. Pelegrini &

Cudahay, New York. Jones, Sir Harold S. Life on Other Worlds, 2nd ed. 1952. English Univerities Press, London.

Kuiper, Gerald P. Atmospheres of the Earth and Planets.
2nd ed. 1952. University of Chicago Press, Chicago. Kuiper, Gerald P. ed. Solar System. 1953-54. University of

Chicago Press, Chicago. 2 v. Lederberg, J., and Cowic, D. B. Moondust; the study of this covering layer by space vehicles may offer clues to the biochemical origin of life. Science, 127, 1473-75 (1958).

^a The opinions and conclusions contained herein are those of the authors and do not necessarily reflect the views or indorsement of the Department of the Army.

Miller, S. L. A production of amino acids under possible primitive earth conditions. Science, 117, 528 (1953).

Moore, Patrick. Guide to the Planets. 1954. Norton, New York.

Platt, J. R. On the nature and color of the moon's surface.

Science, 127, 1502-03 (1958).
Poole, J. H. G. The evolution of the atmospheres. Sci. Proc.

Roy. Dublin Soc., 22, 345 (1941). Rice, F. O. The chemistry of Jupiter. Sci. American, 194, 119 (1956).

Ryan, C. Conquest of the Moon. 1953. Viking Press, New York.

Sholto Douglas, J. W. E. H. Farming on the moon; the possibility of utilizing soilless cultures to produce crops under Lunar conditions. J. Brit. Interplanet. Soc., 15, 17-28 (1956)

Silpher, E. C., and others. The Study of Planetary Atmos-pheres. Final Report. 1952. Lowell Observatory, Flag-

staff, Ariz.

Strughold, Hubertus. Ecological aspects of planetary atmospheres with special reference to Mars. J. Aviation Med., 23, 130-40 (1952). In Epitome of Space Medicine, paper no. 17.

Strughold, Hubertus. The ecosphere of the sun. J. Aviation Med., 26, 323-28 (1955). În Epitome of Space Medicine,

Strughold, Hubertus. Life on Mars in View of Physiological Principles. 1953. USAF School of Aviation Medicine, Randolph Field, Texas. In Epitome of Space Medicine, paper no. 3.

Strughold, Hubertus. The oxygen belt in the planetary system. J. Astronautics, 3, 27-29 (1956). In Epitome of Space

Medicine, paper no. 30.

Strughold, Hubertus. The possibilities of an inhabitable extraterritorial environment reachable from the earth. J. Aviation Med., 28, 507-12 (1957). In Epitome of Space Medicine, paper no. 38.

Urey, H. O. The Planets, Their Origin and Development. 1952. Yale University Press, New Haven, Conn.

de Vaucoulerus, G. Physics of the Planet Mars. 1953. Faber & Faber, London.

Whipple, F. L. Earth, Moon and Planets. 1946. The Blakiston Co., Philadelphia.

Special Problems to Be Faced

Berry, Charles A. The environment of space in human flight. Submitted to Aeronaut. Eng. Rev. In Epitome of Space Medicine, paper no. 41.

Grimminger, F. Probability that a meterorite will hit or penetrate a body situated in the vicinity of the Earth. J. Appl.

Physics, 19, 947 (1948).

Space pioneer: Sicentists test men and materials for future rocket flights; Some human problems. Wall Street J.,

Dec. 4, 1957, p. 1, 13. Stewart W. K. High altitude and space travel. Roy. Soc. Prom. Health J., 76, 423-4 (1956).

Strughold, Hubertus. Atmospheric space equivalence. J. Aviation Med., 25, 420-24 (1954). In Epitome of Space Medicine, paper no. 23.

Strughold, Hubertus, and Haber, Heinz. Where does space begin? Functional concept of the boundaries between atmosphere and space. J. Aviation Med., 22, 342-49A (1951). In Epitome of Space Medicine, paper no. 15.

Experience from Balloon Flights

National Geographic Society-U. S. Army Air Corps Stratosphere Flight of 1935 in the Balloon Explorer II. 1937. National Geographic Society, Washington, D. C.

Piecard, A. Ballooning in the stratosphere. National Geog.

Mag., 63, 353-84 (1933).

Simons, David G. Methods and results of one year of balloon flights with biological specimens. J. Aviation Med., 25, 4 (1954).

Simons, David G., and Parks, D. P. Climatization of animal capsules during upper stratosphere balloon flights. JetPropulsion, 26, 565-68 (1956).

Stevens, Capt. Albert W. Exploring the stratosphere. National Geog. Mag., 66,-397-434 (1934).

SPACE MEDICINE

General (Books and Collections)

Armstrong, H. G. Principles and Practices of Aviation Medicine, 3d ed. 1952. Williams & Wilkins, Baltimore, Md.

Epitome of Space Medicine. 1957. USAF School of Aviation Medicine, Air University, Randolph AFB, Texas. A reprint of 41 reports on various phases of space medicine, many of which are listed by subject in this bibliography.

Marbarger, John P. ed. Space Medicine: The Human Factor in Flights Beyond the Earth. 1951. University of Illinois

Press, Urbana, Ill.

McFarland, Ross A. Human Factors in Air Transportation: Occupational Health and Safety. 1953. McGraw-Hill Book Co., New York.

Space travel: a symposium. J. Aviation Med., 28, 479-512 (1957). Papers presented at 28th annual meeting of the Aero Medical Association, Denver, Colo., May 8, 1957.

General—Single Articles

Becker, Freysing H., and Clamann, H. G. Die Wirkung langdauernder Sauerstoffatmung in verschiedenen Hoehen auf den Menschen. Luftfahrtmedizin, 7, 272-291 (1943). Benson Otis O., jr. Rocket era medical research nears "theory"

end; Trail now leads to space flight experiments. Army Navy Air Force J., 95, 1, 11, 21 (Oct. 12, 1957).

Beyer, D. H., and Sells, S. B. Selection and training of personnel for space flight. J. Aviation Med., 28, 1-6 (1957). In Epitome of Space Medicine, paper no. 35.

Buettner, K. Bioclimatology of manned rocket flight. In Marbarger, John P. ed. Space Medicine. 1951. University of Illinois Press, Urbana, Ill.

Campbell, P. Orientation in space. In Marbarger, John P. ed. Space Medicine. 1951. University of Illinois Press, Urbana, Ill.

Clark, B., and Graybiel, A. The break-off phenomenon. J. Aviation Med., 28, 121-26 (1957).

Haber, Heinz. The astrophysicists views. J. Aviation Med., 28, 487-92 (1957).

Haber, Heinz. Manned flight at the borders of space: The human factor of manned rocket flight. J. Am. Rocket Soc., 22, 269-76 (1952). In Epitome of Space Medicine, paper

Kendricks, Edward J., Strughold, Hubertus, Haber, Heinz, and Siegfried, J. G. Medical problems of space flight. In-structors J. (Air Training Command), (1954). In Epitome of Space Medicine, paper no. 9.

Outward bound. Time, 71, 68-78 (May 26, 1958).

Poppen, J. R. Five years of space medicine. J. Aviation Med., 25, 366-67 (1954).

Strughold, Hubertus. From aviation medicine to space medicine. J. Aviation Med., 23, 315-18 (1952). In Epitome of Space Medicine, paper no. 21.

Strughold, Hubertus. Mechanoreceptors, gravireceptors. J. Astronautics, 4, 61-63 (1957). In Epitome of Space Medi-

cine, paper no. 39.

Strughold, Hubertus. Medical problems involved in orbital space flight. Jet Propulsion, 26, 745-48, 756 (1956). In Epitome of Space Medicine, paper no. 32.

The Human Body

Haber, Heinz. Human body in space. Sci. American, 184, 16-19 (1951). In Epitome of Space Medicine, paper no. 12.

Oparin, A. I. The Origin of Life. 1938. Macmillan Co., New York.

Physiological Factors

Fenno, R. M. Man's milieu in space; Summary of physiological requirements of man in sealed cabin. J. Aviation Med., 25, 612-22 (1954). In Epitome of Space Medicine, paper no. 26.

Jongbloed, J. Ruimtevaert-genee-skude. (Physiological effects of space travel.) Aeromedica Acta (Soesterberg), 4, 11-17

Lansberg, M. P. The function of the vestibular sense organ and the construction of a satellite. Aeromedica Acta, 4, 172-80 (1955).

Luft, U. Physiological limitations in cabin environment and human adaptations. In White, C. S. and Benson, O. O. jr. Physics and Medicine of the Upper Atmosphere. 1952. University of New Mexico Press, Albuquerque, N. M.

Strughold, Hubertus. The Physiological Day-night Cycle in Global Flights. 1952. USAF School of Aviation Medicine, Air University, Randolph Field, Texas. (Special report.) In Epitome of Space Medictne, paper no. 5.

When to eat, sleep, space flight factors; day night cycle problem. Aviation W., 65, 59 (Dec. 24, 1956.)

Weightlessness-Subgravity

Ballinger, E. R. Human experiments in subgravity and prolonged acceleration. J. Aviation Med., 23, 319 (1952).

von Beckh, H. J. A. Experiments with animals and human subjects under sub- and zero-gravity. J. Aviation Med., 25, 235 (1954)

Gauer, O., and Haber H. Man under gravity-free conditions. In German Aviation Medicine, World War II. v. 1, Ch. VI-G. U. S. Govt. Print. Off., Washington, D. C.

Gerathewohl, Siegfried S. Comparative studies of animals and human subjects in the gravity-free state. J. Aviation Med., 25, 412-19 (1954). In Epitome of Space Medicione,

Gerathewohl, Siegfried S. The labyrinthine posture reflex (righting reflex) in the cat during weightlessness. J. Aviation Med., 28, 345-55 (1957). In Epitome of Space

Medicine, article no. 36.

Gerathewohl, Siegfried S. Personal experiences during short periods of weightlessness reported by sixteen subjects. Astronaut. Acta, 2, 303-17 (1956). In Epitome of Space Medicine, article no. 29.
Gerathewohl, Siegfried S., Strughold, H., and Stallings, H. D.

jr. Sensomotor performance during weightlessness: Eyehand coordination. J. Aviation Med., 27, 7-12 (1957). In Epitome of Space Medicine, article no. 34.

Haber, Heinz. Gravity, inertia and weight. In White, C. S., and Benson, O. O. jr. Physics and Medicine of the Upper Atmosphere. 1952. University of New Mexico Press, Albuquerque, N. M.

Haber, Fritz, and Haber, Heinz. Possible methods of producing the gravity-free state for medical research. J. Aviation Med., 21, 395-400 (1950). In Epitome of Space Medicine, paper no. 2.

Haber, Heinz, and Gerathewohl, S. J. On the physics and psychophysics of weightlessness. J. Aviation Med., 22, 180-89 (1951). In Epitome of Space Medicine, paper no.

Simons, D. G. Review of biological effects of subgravity and weightlessness. Jet Propulsion, 25, 209 (1955).

Decompression and High Altitudes

Beischer, D. E., and Born, S. The "boiling" phenomenon of living tissue at low atmosphere pressure. J. Aviation Med., 28, 154-160 (1957).
Christie, R. V., and Loomis, A. L. The pressure of aqueous vapour in the alveolar. J. Physiol., 77, 35 (1933).
Haber, Fritz. Bailout at very high altitudes. J. Aviation Med., 23, 329-20 (1959). In Enternal of Seven Medicine.

23, 322-29 (1952). In Epitome of Space Medicine, paper

Harvey, E. N., and others. Bubble formation in animals. J. Cellular Comp. Physiol., 24, 1, 23, 117, 133, 257, 273 (1944). A series of six articles.

Hitchcock, F. A., and Kemph, J. The boiling of body liquids at extremely high altitudes. J. Aviation Med., 26, 289 (1955).

Hornberger, W. Decomposition sickness. In German Aviation Medicine, World War II. v. 1. 1950. U. S. Govt. Print. Off., Washington, D. C.

Loewy, A., and Wittkower, E. The Pathology of Altitude Climate. 1937. Oxford University Press, London.

Pugh, L. G., and Ward, M. P. Some effects of high altitude on man. Lancet (London), 271, 1115-21 (1956).

Ward, Julian E. The true nature of the boiling of body fluids in space. J. Aviation Med., 27, 429-39 (1956). In Epitome of Space Medicine, paper no. 33.

Atmosphere in Cabins

Clamann, Hans G. Continuous recording of oxygen, carbon dioxide and other gases in sealed cabins. J. Aviation Med., 23, 330-33 (1952). In Epitome of Space Medicine, article

Dryden, Charles E., and others. Artificial Cabin Atmosphere Systems for High Altitude Aircraft. 1956. Wright Air

Development Center, Dayton, Ohio. (WADC Tech. Report 55-353.)

Fenn, W. O. Physiology of Exposures to Abnormal Concentrations of the Respiratory Gases: Studies in Respiratory Physiology. 1951. USAF Wright Air Development Center, Dayton, Ohio. (AF Technical Report 6528.)

Schaefer, E. K. Studies of carbon dioxide toxicity. Chronic CO2 toxicity in submarine medicine. MRL no. 181,

156 - 76.

Specht, H. Toxicology of travel in the aeropause. In White, C. S. and Benson, O. O. jr. Physics and Medicine of the Upper Atmosphere. 1952. University of New Mexico Press, Albuquerque, N. M.

Acceleration

Dixon, F., and Patterson, J. L. Determination of Accelerative Forces Acting on Man in Flight and in the Human Centrifuge. 1953. U. S. Naval School of Aviation Medicine, Naval Air Station, Pensacola, Fla.

Preston-Thomas, H., and others. Human tolerance to multistage rocket acceleration curves. J. Aviation Med., 26, 390

(1955)

Steele, J. E. The cause of motion sickness. Aero Med. Assoc. Annual meeting, Chicago, April 1956.

Flocculation Reaction and Radiation

Buettner, Konrad. Radiation effects on man in space. Bull. Am. Meterol. Soc., 32, 183-85 (1951). In Epitome of Space Medicine, paper no. 13.

Burnight, T. R. Soft X-radiation in the upper atmosphere. Phys. Rev., 76, 165 (1949).

Duell, B., and Duell, T. Zur Frage Solaraktiver Einfuss auf die Psyche. Z ges. Neurol. Psychiat., 162, 495 (1938). Purcell, J. D., Tousey, R., and Watanabe, K. Observations at

high altitude of extreme ultraviolet and X-rays from the sun. Phys. Rev., 76, 165 (1949)

Schaefer, H. J. Exposure hazards from cosmic radiation. J. Aviation Med., 23, 334 (1952).

Takata, M., and Dohmoto, M. Über eine neue Methode zur Bestimmung der Flockungszahl des Blutserums. Tohoku

J. Exptl. Med., 28, 522 (1936).

Takata, M., and Murasugi, T. Flockungszahlstoerung im gesunden menschlichen Blutserum, Kosmoterrestrischer Symbolium Park. 6, 17 (1940) pathismus. Bioklimat. Beibl., 8, 17 (1942)

Takata, S. The flocculation reaction at high altitudes. Tohoku

Takata, S. The noccutation reaction at might attributes. Johnson J. Exptt. Med., 50, 87 (1949).
Van Allen, James A. The nature and intensity of the cosmic radiation. In White, C. S. and Benson, O. O. jr., eds. Physics and Medicine of the Upper Atmosphere. University of New Mexico Press, Albuquerque, N. M.

Bibliographies

Hoff, E. C., and Fulton, J. F. Bibliography of Aviation Medicine. 1942. C. C. Thomas, Springfield, Ill. (Yale Medical

Library. Historical library. Publication no. 5.)

Hoff, P. M., Hoff, E. C., and Fulton, J. F. Bibliography of Aviation Medicine; Supplement. 1944. C. C. Thomas, Springfield, Ill.

Jacobius, Arnold J., and Wilkins, M. J. Aviation Medicine, an Annotated Bibliography, 1952. 1956. Technical Information Division, Library of Congress, Washington, D. C. U. S. National Library of Medicine. Reference Division.

Bibliography of space medicine. Washington, U. S. Govt. Print. Off., 1958. 49 p. (Public Health Service publication no. 617; Public Health Service bibliography series, no 21.) 381 entries.

SPACE PSYCHOLOGY

Berne, E. The psychological structure of space with some remarks on Robinson Crusoe. Psychoanal. Quart. (Albany), 25, 459-67 (1956).

Beyer, D. M., and Sells, S. B. Selection and training of personnel for space flight. J. Aviation Med., 28, 1-6 (1957). Gerathewohl, Siegfried S. Physics and psychophysics of weightlessness: visual perceptation. J. Aviation Med., 23, 373-95 (1952). In Epitome of Space Medicine, paper 22. Haber, H., and Gerathewohl, S. J. Physik und Psychophysik der Gewichtelesigheit Weltraumfahrt 4 44 (1953) der Gewichtslosigkeit. Weltraumfahrt, 4, 44 (1953).

Haber, Heinz, and Gerathewohl, S. J. On the physics and psychophysics of weightlessness. J. Aviation Med., 22, 180-89 (1951). In Epitome of Space Medicine, paper 14.

Poppen, J. R. Man's adaptation to increasing altitude. Soc.

Automotive Engrs. Trans., paper no. 749. (1956).
Germain, A. V. Physiological aspects of interplanetary travel. Am. Helicopter, 21, 10-12, 19 (Jan. 1951).
Slater, A. E. Sensory perception of the weightless condition.

Brit. Interplanet. Soc. Ann. Rep., 1952: 342-48.
Ward, J. E., and Steinkamp, G. R. Human engineering of the sealed space cabin. Texas State J. of Med., 54: 356-57, June 1958.

SPACE ENGINEERING

General

- The Age of Space; a Nontechnical Conference on Missiles, Rockets and Space Travel-and Their Impact on our Times. 1957. Southern Research Institute, Birmingham, Alabama. Includes seven papers presented to the confer-
- Aubrey, C. T. Practical aspects of space ship design and interplanetary travel. J. Soc. Automotive Engrs., 60, 18-23 (1953).
- Clamann, Hans G. Problems of respiratory metabolism in sealed cabins. In Epitome of Space Medicine, Paper no. 40. Submitted for publication to the J. Brit. Interplanet. Soc.
- Haldane, J. B. S. The purification of air during space travel. J. Brit. Interplanet. Soc., 14, 87-89 (1955).
- Haviland, R. P. Air for space ship. J. Astronautics, 3, 31-32, 48 (Summer, 1956.)
- Hecht, F. Chemical Problems of Space Flight. 1952. Third International Astronautical Congress, Stuttgart.
- Mayo, A. M. Environmental consideration of space travel from the engineering viewpoint. J. Aviation Med., 27, 379-80
- Nicoll, N. R. Design of life compartment necessary for space
- travel. J. Brit. Interplanet. Soc., 13, 277-82 (1954).

 Strughold, Humbertus. The U. S. Air Force experimental sealed cabin. J. Aviation Med., 27, 50-52 (1956). In Epitome of Space Medicine, paper no. 28.
- U. S. Congress. Joint Committee on Atomic Energy. space propulsion by nuclear energy; Hearings, 85th Cong. 2nd Sess., Jan. 22, 23, and Feb. 6, 1958. Washington, U. S.
- Govt. Print. Off., 1958. 232 p.
 Welles, A. E. Jr., and Bagley, F. L. Jr. Space vehicles as thermodynamic systems. Battelle Technical Review, 7 (5) 3-9 (1958).
- Wendt, G. Space ship and the man-made moon. J. Soc. Automotive Engrs., 57, 29-33 (1949).

For Algae Culture

- Cook, Paul M. Chemical engineering problems on large scale culture of Algae. Ind. Eng. Chem., 43, 2385 (1951).
- Fisher, Austin W. jr. Engineering for Algae culture. Proc. World Symposium on Appl. Solar Energy. 1955. Phoenix, Ariz.
- Golueke, Clarence G., Oswald, W. J., and Gotnas, H. B. Animal Food Production from Waste Waters. Sanitary Engineering Research Laboratory, University of California, Berke-
- Golueke, Clarence G., Oswald, W. J., and Gotaas, H. B. Anaerobic digestion of Algae. Appl. Microbiol., 5, 47-55 (1957).
- Grau, C. R., and Klein, N. W. Sewage-grown Algae as a Feedstuff for Chicks. 1957. Sanitary Engineering Re-
- search Laboratory, University of California, Berkeley.
 Oswald, W. J., and others. Algae in Waste Treatment. Sanitary Engineering Research Laboratory, University of California, Berkeley, Cal.
- Tamiya, Hiroshi. Growing Chlorella for food and feed. Proc. World Symposium on Appl. Solar Energy. 1955. Phoenix,

SPACE FEEDING SYSTEMS

General°

- Biological problems of space flight; a report of Professor Haldane's lecture to the Society on April 7, 1951. J. Brit.
- A number of the works listed under GENERAL MATERIALS ON MAN IN SPACE. Space Travel, above, include short statements on feeding problems in space.

Interplanet. Soc., 10, 154-55 (1951).

- Bowman, N. J. The food and atmosphere control problem in space vessels. II. The use of algae for food and atmosphere control. J. Brit. Interplanet. Soc., 12, 159-66 (1953).
- Bowman, N. J. The food and atmosphere control problem in space vessels. I. Chemical purification of air. J. Brit. Interplanet. Soc., 12, 118-23 (1953).
- Brooks, F. A. More food from solar energy. 1955. Proc. World Symposium on Appl. Solar Energy, Phoenix, Ariz.
- Fenno, Richard M. Man's milieu in space (a summary of the physiological requirements of man in a scaled cabin.) J. Aviation Med., 25, 612-22 (1954). In Epitome of Space Medicine, paper no. 26.
- Gaume, James G. Plants as a means of balancing a closed ecological system. J. Astronautics, 4, 72-75 (1957). In Epitome of Space Medicine, paper no. 37.
- Haldane, J. B. S. The purification of air during space travel.
- J. Brit. Interplanet. Soc., 14, 87-89 (1955). Kilbuck, J. H. Foods for the spaceman. Food Technol., 11, sup. 2, 5-6, (July, 1957).
- Kooistra, John A., jr., and Harris, Norman O. Metabolic Studies with Lactobacillus under Certain Space Flight Conditions. 1957. USAF, School of Aviation Medicine, Air University, Randolph AFB, Texas. (58-39).
- Lee, M. F., Henry, J. P., and Ballinger, E. R. Basic requirements for survival of mice in a scaled atmosphere. J. Aviation Med., 25, 399 (1954).
- Ley, Willy. Space satellite crew to subsist on frozen foods. Quick Frozen Foods, 20, 54-56 (Nov. 1957).
- Ley, Willie. Spaceman on earth satellite to subsist on frozen
- foods. Quick Frozen Foods, 18, 50-51 (May 1956). Luft, U. C. Physiological limitations in cabin environment and human adaptation. In White, C. S., and Benson, O. O., jr. Physics and Medicine in the Upper Atmosphere.
- University of New Mexico Press, Albuquerque, N. M. Mayo, A. Some survival aspects of space travel. J. Aviation Med., 28, 498-503 (1957).
- Murray, W. D. A gondola for physiological research. J. Aviation Med., 25, 354 (1954).
- Myers, Jack. Basic remarks on the use of plants as biological gas exchangers in a closed system. J. Aviation Med., 25, 407-11 (1954). In Epitome of Space Medicine, paper no.
- Tiller, P. R., Greider, H. R., and Grabick, E. Effects of pilots' tasks on metabolism. J. Aviation Med., 28, 27-33 (1957).
- Ziemba, John V. Technologists create foods for air- and spacemen. Food Eng., 30, 50-53 (March 1958).

Effects of Radiation

- Buettner, Konrad. Versuche über die Durchdringende Strahlung. Z. Geophysik, 3, 161-84 (1927).
- Hess, V. F., and Eugster, S. Cosmic Radiation and Its Biologi-cal Effects. 1949. Fordham University Press, New York. Krebs, A. T. The possibility of biological effects of cosmic
- rays in high altitude, stratosphere and space. J. Aviation Med., 21, 481 (1950).
- Schaefer, H. J. Evaluation of present day knowledge of cosmic radiation at extreme altitude in terms of the hazard to health. J. Aviation Med., 21, 375 (1950).

Conditions of the Planets

- Franck, J. Possibility of photosynthesis on Mars. In Kuiper, G. P. The Atmospheres of the Earth and Planets. 1947. University of Chicago Press, Chicago.
- Jones, Spencer H. Life on Other Worlds. 1949. Macmillan Co., New York.
- Mauder, E. W. Are the Planets Inhabited? 1913. Harper & Bros., New York.
- Sholto Douglas, J. W. E. H. Farming on the moon: The possibility of utilizing soilless cultures to produce crops under Lunar conditions. J. Brit. Interplanet. Soc., 15, 17-28
- Strughold, Hubertus. Comparative Ecological Study of the Chemistry of the Planetary Atmosphere. 1953. USAF School of Aviation Medicine, Air University, Randolph Field, Texas. (Special report.) In Epitome of Space Medicine, paper no. 8.
- Strughold, Hubertus. The Green and Red Planet, a Physiological Study of the Possibilities of Life on Mars. 1953. University of New Mexico Press, Albuquerque, N. M.

ALGAE AS SOURCE OF \mathbf{O}_2 AND FOOD

Bibliography

Lavery, John, and Tischer, Robert G. Food from Algae; a review of the literature. Quartermaster Food and Container Institute for the Armed Forces, Library Branch. Library bulletin no. 1. (In press.)

As a Food Source

Algae as a food source. Chem. Eng. News, 35, 29 (2) (1957). Algae-bacterial symbiosis may produce food for all. Public Works, 85, 108+ (1954).

Black, W. A. P. Seaweeds and their constituents in foods for man and animal. Chem. & Ind., 1955: 1640-5. Discussion,

The universally well-fed future. In The Changing World of Food. 1957. Dodge & Olcott, New York.

Carpenter, A. Weird crops of the future. Sci. Digest, 30, 52-6 (1951).Chapman, V. J. Seaweeds and Their Uses. 1950. Methuen &

Co., London. Cook, J. G. Farming the seas for food. Sci. Digest, 42, 69-72

Dauckwerts, P. V., and Seelers, E. S. Food from Algae and yeast. Food, 21, 459-61 (1952); 22, 23-25 (1953).

Davidson, B. Now bread from the sea; with editorial comment. Colliers, 133, 62-6, 102 (Apr. 16, 1954). Food or fuel from Algae? Sci. Digest, 35, 44-7 (1954).

Food from seaweed; factory of Moray Firth seawced products.

Elec. Rev., 150, 824 (1952).

Food harvest from sewage is oxidation pond bonus. Eng. News-Rec., 149, 39 (June 24, 1952). Same: Sci. American, 187, 32 (Ag. 1952).

Gaffron, H. Food from Algae. Research, 6, 222-30 (1953) Gaume, James G. Plants as a means of balancing a closed ecological system. J. Astronautics, 4, 72-75 (1957).

Hundley J. M., and others. Algae as sources of lysine and threonine in supplementting wheat and bread diets.

Science, 124, 566-37 (1956). Kirschninck, H. Beitrag zur Frage: Brot mit Algenmehlzusatz.

Hippokrates (Stuttgart), 27, 421-22 (1956).

Milner, H. W. Algae as food; chlorella. Sci. American, 189, 31-5 (Oct. 1953).

Morimura, Y., and Tamiya, N. Preliminary experiments in use of Chlorella as human food. Food Technol., 8, 179-82 (1954).

Myers, Jack. Basic remarks on the use of plants as biological gas exchangers in a closed system. J. Aviation Med., 25, $\overline{407}$ –11 (1954).

New process turns sewage to cheap animal food. Chem. Eng., 61, 372-74 (1954).

Newton, Lily. Seaweed Utilization. 1951. Sampson Low, London.

Schlier, Le Roy, McClure, L. E., and Dunn, M. S. Amino acid composition of *Chlorella*. Food Research, 18, 377 (1953). Spoehr, H. A. Chorella as a source of food. Proc. Am. Phil. Soc. 95, 62-7 (1951).

Spoehr, H. A. New look at the food problem. N. Y. Bot. Garden J., 2, 133-34 (1952).

Teeri, A. E., and Bieber, R. E. B-complex vitamins in certain

brown and red Algae. Science, 127, 1500 (1957).

Tseng, C. K. Seaweed products and their use in America.

N. Y. Bot. Garden J., 47, 553 (1946).

Tsmiya, H. Growing Chlorella for food and feed. 1955. Proc. World Symposium on Applied Solar Energy, Phoenix,

Woodward, N. Seaweeds as a source of chemicals and stock feed. J. Sci. Food Agr., 2, 477-87 (1951).

General

Chapman, V. J. The aims of future research in the Algae. Farlowia, 1, 5-8 (1943).

Chapman, V. J. An Introduction to the Study of Algae. 1941. Macmillan Co., New York.

Coulson, C. B. Proteins of marine Algae. Chem. & Ind., 1953:

Cramer, M., and Myers, J. Nitrate reduction and assimilation in Chorella. J. Gen. Physiol., 32, 93-102 (1948).

Davis, E. A. Quantitative studies of factors influencing the growth of Chlorella pyrenoidosa. Carnegie Inst. of Wash. Yrbk, 51, 137-38 (1951). Myers, Jack. Physiology of the Algae. Ann. Rev. Microbiol., 5, 157-80 (1951).

Myers, Jack, and Johnston, J. Carbon and nitrogen balance of Chlorella during growth. Plant Physiol., 24, 111 (1949).

Spoehr, H. A., and Milner, H. W. Chemical composition of Chlorella. Plant Physiol., 24, 120 (1949).

Vinogradov, A. P. The Elementary Chemical Conformation of Marine Organisms. 1953. Sears Foundation of Marine Research, Yale University, New Haven, Conn.

Algae Culture

Burlew, John S. Algal Culture, from Laboratory to Pilot Plant. 1953. Carnegie Institution of Washington, Washington, D. C. (Publication 600.)

Geohegan, M. J. Experiments with Chlorella at Jeallots Hill. In Proc. World Symposium on Applied Solar Energy, Phoenix. 1955. Stanford Research Institute, Menlo Park,

Milner, H. W. Some problems in large scale culture of Algae. Sci. Month., 80, 15-20 (1955).

Pringsheim, E. G. Pure Cultures of Algae. 1946. Cambridge

University Press, London.

Provasoli, L., and McLaughlin, J. J. A. The development of artificial media for marine Algae. Archiv f. Mikrobiol., 25, 392-428 (1957).

Pruess, Louis, and others. Studies on the mass culture of various Algae in carboys and deep-tank fermentations. Appl.

Microbiol., 2, 125-30 (1954).

Scherer, William F., and others. Introduction to Cell and Tissue Culture. 1954. Burgess, Minneapolis, Mi

Sur Cutture. 1904. Burgess, Minneapons, Minn.

Sun power from large-scale culture of Algae nearer as pilot plant reports success. Heat & Vent., 48, 104 (1951).

Thomas, W. H., and Kraus, R. W. Nitrogen metabolism in Scenedesmus Obliquus (Strain WH-50) as affected by environmental changes. Plant Physiol., 30, 2, 113 (1955).

White Dailin B. Cultisation of Animal and Plant Cells. 1054.

White, Phillip R. Cultivation of Animal and Plant Cells. 1954.

Ronald, New York. Willmer, E. N. Tissue Culture. 1954. John Wiley, New York.

Reactions to Light and Radiation

Aronoff, S. Photosynthesis. Botanical Rev., 23, 65-107 (1957). Burk, D., and Warburg, O. Quantum mechanism and energy cycle process in photosynthesis. Naturwissenschaften, 37, 560 (1950).

Downes, Helen R. Chemistry of Living Cells. 1955. Harper & Bros., New York.

Emerson, R., and Lewis, C. M. The dependence of the quantum yield of Chlorella photosynthesis on wavelength of light. Am. J. Botany, 30, 165-78 (1943).

Fogg, Gordon E. The Metabolism of Algae. 1953. John Wiley, New York. (Methuen's monographs on biological sub-

Kok, Bessel. Photosynthesis in flashing light. Carnegie Inst. of Wash. Yrbk., 51. (1951-52). Krauss, Robert W. Photosynthesis in the Algae. Ind. Eng.

Chem., 48, 1449-55 (1956).

Krumholtz, L. A. A summary of findings of the ecological survey of White Oak Creek, Roane County, Tennessee, 1950-1953. 1954. Technical Information Service, U. S. Atomic

1953. 1954. Technical Information Service, U. S. Atomic Energy Commission, Oak Ridge, Tenn. (ORO-132).

Morgan, L. O., and Myers, J. Biological Accumulation of Inorganic Materials by Algae. Final report to the United States Atomic Energy Commission. 1953. Department of Zoology, University of Texas, Austin, Texas.

Myers Tech. Algae as an energy converter. Proc. World Sum.

Myers, Jack. Algae as an energy converter. Proc. World Sym-

posium on Appl. Solar Energy, Phoenix, Ariz. 1955. Stanford Research Institute, Menlo Park, Cal.

Myers, Jack. Influence of light intensity on photosynthetic characteristics of Chorella. J. Gen. Physiol., 29, 429-440

Phillips, J. N. jr., and Myers, J. Growth of Chlorella in flash-

Phillips, J. N. Jr., and Myers, J. Growth of Chiorella in massing light. Plant Physiol., 29, 152-61 (1954).

Phillips, J. N. jr., and Myers, J. Growth of Chlorella in intermittent light. Carnegie Inst. of Wash. Yrbk., 51. 1951-52.

Turner, J. S., Todd, Mary, and Brittain, E. G. The inhibition of photosynthesis of O2. I. Comparative physiology of the

effect. J. Biol. Sci., 9, 494-510 (1956).

Warburg, Otto. Photosynthesis; Experiments at the Max Planck Institute for Cell Physiology, Berlin-Dahlem, 1950-57, are described. Science, 128, 68-73 (1958).

Williams Louis G. and Swapson H. D. Concentration of Williams, Louis G., and Swanson, H. D. Concentration of Cesium-137 by Algae. Science, 127, 187-88 (1958).

[5]